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TRANSACTIONS
of
THE NEW YORK ACADEMY OF SCIENCES

SER. II, VOL. 8 JANUARY, 1946* No. 3

SECTION OF GEOLOGY AND MINERALOGY

DECEMBER 3, 1945

DOCTOR RALPH W. IMLAY, United States Geological Survey, Washington, D. C.: *Jurassic and Lower Cretaceous History of the Gulf Region.* (This lecture was illustrated by lantern slides.)

Lower and Middle Jurassic rocks in the Gulf region are known only in southern Mexico and northern Central America. If present in the southern United States, they have not yet been penetrated by drilling. If present in the Antilles, they must be included in the metamorphosed beds forming the basement rocks and have not been identified by fossils. Orogenic movements, near the end of the Triassic, produced geosynclinical conditions in southern Mexico and northern Central America, north of a rising land mass occupying the site of Honduras and southernmost Guatemala, Chiapas, and Oaxaca. Marine waters entered the region of Veracruz, early in Lower Jurassic time, and spread west and southwest as a rather narrow embayment that reached the region of northeastern Guerrero, by late Lower Jurassic time. Marine invasion became more widespread during the Middle Jurassic, as the sediments of that age in Oaxaca and Guerrero change from dominantly carbonaceous or coarse littoral, in their lower part, to sublittoral and normal marine, in their upper part. During the Lower and Middle Jurassic, the southern part of the geosyncline received from 2,000 to 3,000 feet of continental deposits, consisting mainly of vari-

* FOR **Report of Annual Meeting** SEE PAGE 104.

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colored shale, sandstone, conglomerate and coal. Much of the shale is carbonaceous and contains numerous plant remains. Some marl and limestone are interbedded with this continental facies, particularly in its upper part. Farther north, in the Huesteca region of Vera Cruz, eastern Hidalgo and northern Puebla, the Lower Jurassic is represented by more than 1,300 feet of dark, marine shale containing numerous ammonites. Well-preserved plants, occurring at the top of the shale and also associated with ammonites in the lower part of the shale, furnish a correlation with the lower part of the continental facies. The littoral and sublittoral character of most of the Lower and Middle Jurassic sediments and the excellent preservation of some of the plant fossils indicate that marine waters did not occupy much area, but probably occurred as bays and lagoons. The climate must have been hot and humid, at least seasonally, as indicated by the richness of the flora, the presence of considerable coal, and the dark color of much of the shale. The rèd, brown and yellow colors of some of the sandstone and conglomerate do not constitute evidence of aridity, as these sediments are interbedded with dark, carbonaceous and coaly sediments.

During Upper Jurassic time, marine waters spread widely over both southern and northern Mexico, the southern United States, and Cuba. Thicknesses of sediments deposited are in thousands of feet, ranging from 3,000 to 7,000 feet, in the southern United States; from 2,600 to 4,800 feet, in northern Mexico; at least 5,000 feet, in southern Mexico, and at least 6,000 feet, in Cuba. The remarkable uniformity in composition of the Upper Jurassic throughout most of the Gulf region is ascribed to the peneplained condition and the high aridity of the continent, near the beginning of Upper Jurassic time.

During the Callovian stage at the beginning of the Upper Jurassic, the marine waters, according to present knowledge, were restricted to southern Mexico, but were much more widespread than previously in the Jurassic. The deposits consist of shale, marl, limestone, and some sandstone that are mainly dark-colored and bituminous and are locally over 2,000 feet thick. These beds grade downward into the Middle Jurassic marine and continental beds, but their relationship to the overlying Jurassic limestone is not known. They have furnished many ammonites, which show that both the lower and upper Callovian are represented. Their dark color and the considerable quantity of shale suggest that the surrounding land masses had a fairly humid climate.

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The Divesian stage is probably represented in northern Central America, southern Mexico and the southern United States by a salt facies that grades shoreward into a red bed facies. A thick red bed facies, at least partly continental in origin, was formed throughout northern Mexico. The distribution of salt in southern Mexico is shown mainly by salt domes and salt springs. Its distribution in the United States is shown by bedded salt deposits around the margins of the basins and by penetration salt domes in the centers of the basins. According to R. H. Palmer, several domelike structures in northern Cuba appear to be salt domes. The salt and red beds are represented in the southern United States by the Eagle Mills formation, that ranges in thickness from 960 to over 1,780 feet and rests unconformably on late Paleozoic rocks. Its Divesian age is shown by gradation of the salt facies into the overlying Smackover limestone and by the presence of upper Argovian ammonites, only 300 feet above the salt. Correlation with the salt and red beds of southern Mexico is indicated by their similar stratigraphic position and by the considerations that both areas of salt deposition were of immense size, were undoubtedly connected with the Gulf of Mexico and were influenced by similar climates. The possibility that the salt in southern Mexico is older than Divesian is very improbable, considering that the older Jurassic beds are well represented by marine fauna that could not have lived in a highly saline environment and by rich flora that, according to Wieland, indicate a tropical climate of the Monsoon forest type. That the climate of Divesian time was particularly favorable for deposition of rock salt is shown by the presence of salt in northern Utah and southeastern Idaho in the medial part of the San Rafael group, below a marine unit of Argovian age and above a marine unit of Callovian age. It seems improbable that the salt masses of Mexico and the southern United States were deposited in separate relic seas, because that would mean that there were two barriers, each about 800 miles long, existing simultaneously and having suitable conditions throughout which might permit replenishment of the waters of the salt basin, until about 1,000 feet of salt were deposited. Rather, the thickness and extent of the salt masses of the Gulf region suggest that the entire Gulf of Mexico was a salt depositing basin, completely enclosed, except for a relatively narrow, shallow strait connecting with the Atlantic Ocean, perhaps in the region between Hispaniola and the Bahamas.

The climate must have been extremely arid for several million years, probably during most of the Divesian stage.

The Argovian stage is represented, in many parts of Mexico and the southern United States, by dark-colored limestone, called the Zuloaga limestone in Mexico and the limestone facies of the Smackover formation in the United States. The Smackover limestone differs from the Zuloaga limestone by containing many oolites in its upper part. Locally, the limestone is interbedded with much sandstone, conglomerate, and some shale which reflects local uplifts. One such area is in southern Coahuila and eastern Durango, where the sediments are known as La Gloria formation. Similar coarse sediments occur in northern Louisiana and are considered a facies of the smackover formation. Thicknesses of rocks of Argovian age range from a few hundred to more than 2,000 feet. Sites of salt deposition during Divesian time gradually became sites of lime deposition during Argovian time, but elsewhere, as in northern Mexico, the Argovian sea transgressed across red beds and older rocks. The Argovian stage in Cuba is represented, according to R. H. Palmer, by about 400 feet of shaly limestone called the Jagua formation. The remarkably uniform appearance of the Argovian sediments throughout most of the Mexican and Gulf Coast geosynclines indicates a uniform, arid climate, few rivers emptying into the sea, and few highland areas. Aridity, plus the peneplained condition of the interior of the continent, account for the scarcity of rivers and for the deposition of calcareous sediments near shore. Correlation of the Smackover formation with the Zuloaga limestone of Mexico and the Jagua formation of Cuba is based on the presence of the ammonites, *Dichotomosphinctes* and *Discosphinctes*, on the ranges of some gastropod genera, and on the occurrence, in the overlying beds, of lower and middle Kimmeridgian ammonites.

Early in the lower Kimmeridgian, marine waters retreated basinward from 50 to 100 miles, giving rise to extensive lagoons, in which accumulated thick masses of anhydrite and red beds. These are known as the Buckner formation, in the southern States, as the Olvido formation, in the Sierra Madre Oriental; and are included in the basal part of the Malone formation in western Texas. The deposits range in thickness from 50 to 1,000 feet and are succeeded basinward by normal marine, dark-colored sediments, which, in Louisiana, have furnished lower Kimmeridgian ammonites of the *genera Ataxioceras* and *Idoceras*.

At the end of the deposition of the anhydrites and red beds of the early Kimmeridgian, occurred the most intense orogeny in North America since the Paleozoic. Orogeny was expressed by block faulting (Palisade disturbance), in the Atlantic Coast region; by the Nevadian orogeny of the Pacific Coast region; by the development of highlands, in the areas of the Ouachita Mountains, the Central Mineral region, the Diablo Plateau, the Coahuila Platform, the eastern margin of the Sierra Madre Oriental and, probably, in many other places. A gentle elevation of the interior of the continent drained the Sundance sea from the area of the United States and caused a temporary retreat of the Gulf waters. All available evidence indicates that the orogeny began early in the Kimmeridgian and was complete by the upper Portlandian. Evidence for the orogeny in the eastern United States is furnished mainly by the thick mass of coarse conglomerates at the base of the Cotton Valley formation. In southwestern Alabama, conglomerates range throughout the lower 1,660 feet of the formation and, according to core and drilling records, contain some boulders more than a foot in diameter.

Late in the lower Kimmeridgian, marine waters transgressed widely in the northern parts of the Gulf of Mexico and the Mexican sea, but Cuba apparently remained a land area until the upper Portlandian. The late Upper Jurassic deposits of the Gulf region range in thickness from a few hundred to a few thousand feet. The offshore deposits consist mainly of bituminous shale and limestone, which, in the southern United States, are known as the normal marine facies of the Cotton Valley group; in Mexico, as La Caja formation, and, in Cuba, as the Quemado formation, and the Viñales limestone. Nearshore deposits contain much conglomerate and sandstone, in addition to shale. They are known, in northern Mexico, as La Casita formation, in western Texas, as the Malone formation, and, in the southern States, are included in the Schuler formation of the Cotton Valley group. The northern part of the Mexican sea was bordered by lagoons, in which some gypsiferous and coaly deposits accumulated. The late Upper Jurassic age of the Cotton Valley formation is shown by the presence in its lower part of many Kimmeridgian fossils including *Idoceras* group of *I. durangense* (Burckhardt) and *Glochiceras fialar*. The climate of the late Upper Jurassic was moister than during the early Upper Jurassic, as shown by the presence of coal beds and carbonace-

ous to bituminous shales. Marine waters retreated slightly from the northern part of the Gulf region at the end of the Jurassic, but uplift was much less than during the early Kimmeridgian, as shown by the thickness and extent of the gravels at the base of the Lower Cretaceous. Erosion of the highlands, formed during the mid-Upper Jurassic orogeny, eventually produced the Fall zone peneplain.

The Lower Cretaceous of the Greater Antilles is little known. Late Lower Cretaceous rocks, similar to the Glen Rose limestone of Texas, have been found in Cuba. Some geologists consider that the Viñales limestone (*Aptychus* limestone) may be partly of early Lower Cretaceous age, although the only ammonites that it has furnished are of late Jurassic age. It would not be surprising to find a considerable sequence of Lower Cretaceous rocks in Cuba or in the other large islands of the Greater Antilles.

The Lower Cretaceous of Central America and Mexico is fairly well known in broad outlines. During the Neocomian, the Mexican sea was confined to the central part of the Mexican geosyncline, was indented by peninsulas in Coahuila and Oaxaca, overlapped islands in eastern Mexico and probably extended westward through Colima and Jalisco and southeastward into northern Central America. Its western margin in the area of Chihuahua, Durango and Zacatecas is still not known. Coarse clastic sediments were formed nearshore mainly during the Berriasian, lower Valanginian and upper Hauterivian. They show considerable variation in character and thickness, from place to place, probably depending on the positions of rivers or of local uplifts. Thin-bedded limestone and marl are interbedded with these coarse sediments and are the characteristic offshore rocks from Berriasian to Hauterivian. The Barremian is represented offshore mainly by thick- to medium-bedded limestone, but nearshore contains some intercalations of shale and sandstone and, locally, gypsum and rock salt.

During the lower Aptian, the Mexican sea was apparently nearly as restricted as during the Neocomian, but, during the upper Aptian and Albian, it spread widely and possibly connected with the Pacific Ocean in both northern and southern Mexico. Throughout central and northern Mexico, a major change in sedimentation occurred in the lower Cenomanian, apparently coinciding with the unconformity between the Comanche and Gulf series in the southern United States.

The lower Aptian of the Mexican geosyncline consists mainly of thick- to medium-bedded limestone, but nearshore contains some shaly

beds, arkosic sandstones and, locally, gypsum and salt. The upper Aptian and basal Albian are represented widely by shale and thin-bedded limestone, but in southeastern Puebla and in Sonora contain much coarse material. The middle Albian and the upper part of the lower Albian are represented by a number of facies. Thin-bedded limestone, interbedded with black chart, was deposited throughout the central part of the Mexican geosyncline. This facies grades marginally and rather abruptly into rudistid- or Orbitolina-bearing limestone which is generally much thicker and was deposited over areas that were landmasses in Jurassic or Neocomian times. This facies, in turn, changes abruptly into a dense, thick-bedded, nonrudistid-bearing limestone which occurs in the Sierra Madre Oriental and the coastal plain north of southern Tamaulipas. In western Coahuila, gypsiferous beds were formed over the site of the Coahuila Peninsula. In east-central Sonora, thousands of feet of limestone, shale, agglomerate and lava were deposited. The upper Albian is represented mainly by wavy-bedded, thin-bedded limestone and many lenses of black chert.

The Lower Cretaceous, penetrated by drilling in southern Florida, consists of a considerable thickness of limestone and anhydrite, of Albian age. In contrast, the lower Cretaceous in southwestern Alabama consists of nearly 4,900 feet of sandstone, reddish shale and some gravel, but contains minor amounts of pink and gray, nodular limestone, toward the top. Similar sections of sandstone and red shale have been found in southern Georgia, northern Florida and in Mississippi. In the western and southern parts of Mississippi, the upper part of the Lower Cretaceous includes some limestone and anhydrite, resembling the Lower Cretaceous farther west.

In the Arkansas-Louisiana-East Texas area, the advancing sea of early Cretaceous time encountered large amounts of gravel derived from the Ouachita Mountain area and spread it widely in southern Arkansas and eastern Texas. The gravel was succeeded upward by large amounts of red to white sand and generally reddish silts and clays which are locally over 2,000 feet thick. These sediments have been named the Hosston formation and are considered to be mainly of Neocomian age. They were succeeded transitionally and transgressively, during Aptian and lower Albian times, by about 350 to 1,200 feet of normal marine sediments, comprising the subsurface Sligo formation, Pine Island shale, James limestone, and Rodessa formation

and consisting of interlensing oolites, coquinas, marls, silt, clay and sand. Toward the end of Rodessa time, several widespread anhydrite layers were formed. The succeeding Ferry Lake anhydrite is unusually interesting. It ranges from 10 to 500 feet in thickness, extends about 800 miles from western Mississippi to eastern Texas, occupies a bed about 150 miles wide, and grades southward into normal marine shale and limestone. It was overlain conformably by as much as 700 feet of clay, silt, lime mud and sand, called the Mooringsport formation. Then followed deposition of the Paluxy sands and variegated clays along the northern margin of the Gulf region, from East Texas eastward. The overlying, relatively thin Fredericksburg limestones and shales of late middle Albian age have been identified as far east as western Mississippi. The Washita limestone of upper Albian age has been definitely identified only as far east as extreme southwestern Arkansas, but the occurrence of *Alectryonia* cf. *A. quadriplicata* (Shumard) in well cores from Tensas Parish, northeastern Louisiana, suggests that the upper Albian limestones may once have extended that far east. Their apparent absence, east of the Mississippi River, may be due to non-deposition, or to change of facies, or to erosion.

Lower Cretaceous sedimentation in South Texas was influenced by the presence of the Central Mineral region which furnished much less sand and clay to the bordering sea than did the highlands in the Ouachita Mountain areas. In comparison with the Arkansas-Louisiana-East Texas area, the Hosston formation is finer and more calcareous; the Sligo formation is thicker, more calcareous, and contains dolomite beds; the upper Aptian beds are similar in the two areas; the thick Glen Rose limestone lacks a persistent unit of anhydrite; the middle Albian sediments are considerably thicker, and the upper Albian sediments are in general thinner, except in the central part of the Rio Grande embayment. At the end of Comanche time, probably during the lower Cenomanian, the Arkansas-Louisiana-East Texas area was subjected to regional uplift, accompanied by extensive normal faulting which displaced the older rocks from 400 to 1,200 feet. Subsequently, the area underwent extensive erosion before deposition of the Gulf series. This uplift apparently had little effect in South Texas, and its influence east of the Mississippi River is unknown.

SECTION OF BIOLOGY

DECEMBER 10, 1945

DOCTOR JAMES B. HAMILTON, Department of Anatomy, Long Island College of Medicine, Brooklyn, New York: *The Relationship Between Common Baldness and Male Sex Hormones.*

Common baldness (alopecia) is a sequela of sexual maturation and is, in most instances, induced by stimulation from male hormone substances. In keeping with this physiological relationship, the incidence of the disease is much higher in males than in females, and extensive forms of the disease are restricted almost entirely to males. Most women with pronounced forms of the disease are those with virilism.

Apparently, age is a factor in the rapidity with which areas of denudation extend. In eunuchs, susceptibility to such loss of hair can increase with age, but baldness does not occur because of inadequacy of testicular secretions. This increased susceptibility accumulates, unspent, like money in the bank, and later treatment of the eunuchs with male hormones (androgens) results in a rapid loss of hair. Available evidence does not bear crucially on the question of whether or not there is, with increasing age, a lowering of the amount of androgenic stimulation required to produce baldness.

The third factor known to be involved is inheritance. No amount of androgenic stimulation produces baldness in persons who lack an inherited tendency to this disease. The realization of this tendency depends, however, upon androgenic stimulation, since, whatever the inheritance, baldness does not ensue without androgenic stimulation.

Local areas of the skin play a dominant role in the atrophic changes that result in baldness. Application of androgens directly to a local area results in piliary changes limited to that region. At the present stage of our information, it must be assumed that androgens are only one of what might be a family of agents (although they are the usual one) which may be capable of inducing atrophic changes in specific areas. The degree of atrophy is controlled by the local areas of skin and does not result from external changes in vascularity or com-

pression of the area by tight bands. Rather, baldness will occur even in skin transplanted from its usual site.

Baldness is one of the so-called degenerative diseases which remain as extremely important medical problems and have not benefited from the achievements of chemotherapeutic control of infectious diseases. It is a condition, the progress of which can be studied. The nature and therapeutic control of the disease can be investigated carefully. Findings from studies of this disease may be presumed to be applicable to a number of the so-called degenerative diseases, like prostatic cancer, which are also prone to occur in the male sex.

SECTIONS OF BIOLOGY AND PHYSICS AND CHEMISTRY

DECEMBER 7 AND 8, 1945

Conference on *"Proteins and Protein Hydrolysates in Nutrition."*

The Sections of Biology, and Physics and Chemistry held a Conference on "'Proteins and Protein Hydrolysates in Nutrition." Doctor James B. Allison, Rutgers University, New Brunswick, New Jersey, was the Conference Chairman, in charge of the meeting.

The program consisted of the following papers:

Introductory Remarks, by James B. Allison.

"Amino Acid Deficiencies in Man," L. Emmett Holt, Jr., New York University, New York, N. Y.

"The Determination of the Nitrogen Balance Index in Normal and Hypoproteinemic Dogs," James B. Allison, John A. Anderson and Robert D. Seeley, Rutgers University, New Brunswick, New Jersey.

"The Evaluation of Protein Quality in the Normal Animal," Richard H. Barnes and David K. Bosshardt, Department of Biochemical Research, Sharp & Dohme, Inc., Glenolden, Pennsylvania.

"Electrophoretic Studies on Plasma Protein Depletion and Regeneration," Bacon F. Chow, Division of Protein Chemistry, The Squibb Institute for Medical Research, New Brunswick, New Jersey.

"Blood Protein Regeneration and Interrelation," G. H. Whipple, F. S. Robsheit-Robbins and L. L. Miller, The University of Rochester, School of Medicine and Dentistry, Rochester, New York.

"Nitrogen Metabolism in Acute and Chronic Disease," John P. Peters, Yale University, School of Medicine, New Haven, Connecticut.

"Clinical Observations Following the Intravenous Injection of a Protein Hydrolysate in Surgical Patients," Robert Elman, Washington University, School of Medicine, St. Louis, Missouri.

"Clinical Experience with Oral Use of Protein Hydrolysates," F. Co Tui, New York University, College of Medicine, New York, N. Y.

REPORT OF THE ANNUAL MEETING

DECEMBER 19, 1945

The 128th Annual Meeting of the Academy, for the election of Officers, Fellows and Honorary Members, the presentation of reports and the transaction of other business was held at the Hotel Astor on the evening of Wednesday, December 19.

The Corresponding Secretary reported that there are now 42 Honorary Members upon the rolls of the Academy. The deaths of 6 Honorary Life Members were reported during the past year.

The Recording Secretary reported that, during the last year, the Academy held 27 Regular Sectional Meetings, in addition to its Annual Meeting, at which 27 stated papers of high scientific caliber were presented.

Ten informal receptions were held under the auspices of the various Sections of the Academy.

Seven two-day conferences on special subjects of research were held during the year. These meetings were attended by outstanding investigators in the fields represented. The titles of the conferences are as follows: Joint Meetings, Section of Biology and Section of Physics and Chemistry, "Blood Grouping," "Proteins and Protein Hydrolysates in Nutrition"; Section of Biology, "Experimental Hypertension," "Lymph"; Section of Physics and Chemistry, "Surface Active Agents," "Amino Acid Analysis of Proteins"; Section of Psychology, "Non-Projective Personality Tests."

Three Honorary Life Members, 2 Life Members, 7 Sustaining Members, 219 Active Members, 62 Associate Members and 14 Student Members were added to the rolls, of which 296 are now in good standing and 11 await qualification through payment of dues. Thus, a total of 307 new members was added during the year. Four Sustaining Members were transferred to Life Membership, having paid dues for twenty-five years. Twenty transfers and 7 reinstatements to membership were also effected between the various classes of membership, with the approval of the Council.

The Academy has lost by death 6 Honorary Life Members, 4 Life Members, 5 Sustaining Members, 11 Active Members and 2 Associate

Members. Thirty-one resignations were accepted, 31 more were dropped for non-payment of dues and 2 for not having qualified for membership.

The record now stands with a net gain of 221 members. There are at present on the rolls of the Academy 2,298 members, of whom 339 are Fellows. These include 1 Patron, 94 Life Members, 119 Sustaining Members, 1,353 Active Members, 651 Associate Members, 38 Student Members and 42 Honorary Life Members.

The Editor reported that, during the fiscal year of 1945, the Academy published a total of 584 pages. Of this amount, 346 pages were published in the Annals and 238 pages in the Transactions. This was less than the record of the previous year, due to the delays in printing occasioned by war priorities. In addition to the Articles published during the year, Articles 6, 7 and 8 of Volume 46, and Article 1 of Volume 47 are in press and will be issued shortly. Volume 46, Article 9 and Volume 47, Article 2 are in the Editor's hands and are being prepared for the printer.

The detailed list of the publications which have appeared this year is as follows:

ANNALS

Volume 46, Article 1, "Animal Colony Maintenance," (8 papers), by Edmond J. Farris, F. G. Carnochan, C. N. W. Cumming, Sidney Farber, Carl G. Hartman, Frederick B. Hutt, J. K. Loosli, Clarence A. Mills, Herbert L. Ratcliffe. Pages 1–126. Published June 15, 1945.

Volume 46, Article 2, "A Hitherto Undemonstrated Zoogleal Form of *Mycobacterium tuberculosis*," by Eleanor Alexander-Jackson. Pages 127–152. Published June 29, 1945. Awarded an A. Cressy Morrison Prize, 1944.

Volume 46, Article 3, "The Effect of Activity on the Latent Period of Muscular Contraction," by Alexander Sandow. Pages 153–184. Published June 30, 1945. Awarded an A. Cressy Morrison Prize, 1944.

Volume 46, Article 4, "Respiration and Germination Studies of Seeds in Moist Storage," by Lela V. Barton. Pages 185–208. Published August 18, 1945. Awarded Honorable Mention, A. Cressy Morrison Prize Competition, 1944.

Volume 46, Article 5, "The Diffusion of Electrolytes and Macromolecules in Solution" (6 papers), by L. G. Longsworth, Charles O. Beckmann, Margaret M. Bender, Edward M. Bevilacqua, Ellen B. Bevilacqua, Douglas M. French, A. R. Gordon, Herbert S. Harned, Lars Onsager, Jerome L. Rosenberg, and J. W. Williams. Pages 209–346. Published November 30, 1945.

TRANSACTIONS

Series II, Volume 7, Nos. 1–8, consisting of 238 pages, was completed, printed and distributed each month from November, 1944 to June, 1945, inclusive.

The Librarian reported that, during the year 1945, the Academy

distributed 26,893 separate publications and 3,624 complete volumes of the various published series, as follows:

Separate Numbers—*Annals,* 18,548: *Scientific Survey of Porto Rico and the Virgin Islands,* 997; *Transactions,* Series II, 7,343; *Memoirs,* 5.

Volumes—*Annals of the Lyceum,* 184; *Special Publications,* Volumes I and II, 257; *Transactions,* Series I, 19, and Series II, 3,164.

The Library of the Academy has received, from exchange institutions, 1,535 separate publications. With the cessation of hostilities and restoration of communications, shipment of the Annals and Transactions has been made to our exchange institutions, thus bringing many of them up to date, for the first time since September, 1939.

The Treasurer reported that the Academy, while pursuing its established program of progressive activity in the field of science, has also exhibited a corresponding financial development, continuing the progress of recent years.

During the past fiscal year, the total income received from all sources amounted to $39,380.83. This is an increase of $12,754.30 above that of 1944.

Through the hearty cooperation of its membership, the Academy added 307 new names and 7 reinstatements to its rolls, which represents a gain of $724.20 in our revenue from membership dues, making a total of $9,469.50 from this source.

Receipts from sales of publications and library exchanges amounted to $7,215.33.

The income from investments, amounting to $4,333.57, represents a yield of 4.79 per cent, a gain of $637.44 above that of last year.

Through the generosity of Mr. William Otis Sweet, a Sustaining Member, the sum of $2,000 has been added to his previous contribution, which established the William Otis Sweet Fund, last year. The principal of this fund now totals $3,500.*

A grant of $1,000 has been received from the Viking Fund to aid in defraying the cost of the paper by Doctor Earl W. Count, entitled "Brain and Body Weight in Man," which will appear shortly in the Annals.

Additional contributions, totaling $4,500, have been received from

* Announcement also was made at the Annual Meeting that Mr. Sweet had contributed the sum of $7,500 in addition to the above, thus bringing the total amount of the fund to $11,000.

the University of Puerto Rico and the Department of Agriculture and Commerce of Puerto Rico, toward the expense of publishing the Scientific Survey of Porto Rico and the Virgin Islands.

The increased income of the Academy, during the past year, has written off the debit balance of $1,905.30, shown in the Treasurer's report for the year ending November 30, 1944, and has produced a surplus amounting to $2,084.63, as of November 30, 1945.

Through the far-seeing advice of the Finance Committee, the capital funds of the Academy have shown a gain of $6,386.97. This is the margin above the liability to the endowment funds of the Academy.

The book value of the Academy's investments and cash on hand, as of November 30, 1945, now amounts to $96,958.62, as shown on the balance sheet.

The books of the Treasurer were duly checked and balanced at the end of the fiscal year, November 30, 1945, and have been audited by the Finance Committee, as provided by the Constitution and By-Laws.

The property of the Academy was verified and the Treasurer's report examined and attested by the Finance Committee, as of December 15, 1945.

The A. Cressy Morrison Prizes of $200 each for the two most acceptable papers in any field of natural science, within the scope of the Academy and its Affiliated Societies, were awarded to the following papers† entitled:

"Polyelectrons," by John Archibald Wheeler, Princeton University, Princeton, New Jersey.

"Limitations of Optical Image Formation," by Max J. Herzberger, Eastman Kodak Research Laboratories, Rochester, New York.

The Committee of Judges awarded Honorable Mention to the following paper, because of its general excellence:

"The Golgi Apparatus," by Leonard G. Worley, Department of Biology, Brooklyn College, Brooklyn, New York.

The Prize Committee extends its congratulations to the authors of these papers, on behalf of the Academy.

By authority of the Council of the Academy, the Committee takes pleasure in announcing that Mr. Morrison has renewed his offer of

† Abstracts of these papers are included in this issue of the Transactions.

two prizes of $200 each to be competed for during the year, 1946, for the two most acceptable papers in a field of science covered by the Academy or an Affiliated Society. These prizes are to be awarded in December, 1946. The terms of the competition will be published in the next issue of the Transactions.

The Committee also announces, on behalf of Mr. Morrison, that he has offered an Astronomical Prize of $500, in renewal of those awarded in recent years, for the paper, adjudged by the Council of the Academy to be the most meritorious contribution on the subject of solar and stellar energy. In connection with this offer, the following statement has been prepared:

Understanding of the source of solar and stellar energy begins with Helmholtz's contraction theory (1854). As the primordial star contracts, the kinetic energy of the mass particles closing in under the force of gravity is transformed into heat energy. Whereas this is still believed to be cosmologically the first cause of stellar radiation, it has been realized since the end of the previous century that the process of contraction would run to its end in a time that is short as compared to the age of the earth; and, ever since this was realized, astronomers have been compelled to postulate that the Helmholtz contraction must be retarded and, for the major part of the star, probably balanced by an internal pressure caused by energy that does not derive from kinetic energy. The way out of this difficulty was cleared theoretically (1905) by Einstein's law of the equivalence of mass and energy, although the exact mechanism whereby, under stellar conditions, matter would change into radiation, remained still a secret. The first laboratory transmutation of nitrogen into an isotope of oxygen by Rutherford (1917) opened the field of nuclear reactions which led to the experimental results; namely, that the mass lost in a nuclear reaction and the energy set free are in accordance with Einstein's law. By examining all possibilities of reactions that could take place under conditions prevailing in the sun, Bethe (1913) succeeded in singling out the one reaction that should, both as to the requirement of temperature and as to the availability of the elements involved, take place at the proper rate. This is the so-called carbon cycle whereby the energy liberated is equivalent to the mass defect of the helium atom as compared to four hydrogen atoms.

Prodigious progress has been made since the first A. Cressy Mor-

rison Prize on the above subject was offered in 1926. It is, however, felt that the complete answer has not yet been given and many questions remain open. In the first place, no final model for the sun, properly satisfying the observed luminosity and hydrodynamical considerations, has been published. Secondly, at best a start has been made on the problem of the so-called "red giants," "sub dwarfs," and "white dwarfs." Through the continued interest of Mr. Morrison and his desire to stimulate further research in the subject, the above prize will be renewed for award in 1946.

The following members were elected to Fellowship:

Reginald M. Archibald, Ph.D.
Ralph S. Banay, M.D.
John B. Bateman, Ph.D.
Erwin Brand, Ph.D.
Frank Brescia, Ph.D.
Dean Burk, Ph.D.
Wallace M. Cady, Ph.D.
Harry A. Charipper, Ph.D.
Albert Claude, M.D.
Christopher Coates
William P. Comstock, A.B.
Karl K. Darrow, Ph.D.
Thomas B. Drew, M.S.
Walter Dyk, Ph.D.
Gordon F. Ekholm, Ph.D.
William H. Eyster, Ph.D.
Karl A. Folkers, Ph.D.
Raymond F. Fuoss, Ph.D.
William U. Gardner, Ph.D.
Walther F. Goebel
Eli D. Goldsmith, Ph.D.
Manuel H. Gorin, Ph.D.
David E. Green, Ph.D.
Jesse M. Greenman, Ph.D.
Paul B. Hamilton, Ph.D.
Herbert S. Harned, Ph.D.
Harold J. Harris, M.D.
George Herzog, Ph.D.
Horace S. Isbell, Ph.D.
J. Brookes Knight, Ph.D.
Otto Loewi, M.D.
Sandor Lorand, M.D.
William A. Lynch, Ph.D.
Wilbur G. Malcolm, Ph.D.
Douglas A. Marsland, Ph.D.
A. H. Maslow, Ph.D.
Bela Mittelman, M.D.
Hans Molitor, M.D.
Ruth L. Munroe, Ph.D.
David Nachmanson, M.D.
Bernard L. Oser, Ph.D.
Benton B. Owen, Ph.D.
Edward A. Saibel, Ph.D.
Alexander Sandow, Ph.D.
Bobb Schaeffer, Ph.D.
Martin Scheerer, Ph.D.
Charles R. Schroeder, Ph.D.
Joseph E. Smadel, M.D.
William H. Stein, Ph.D.
Robert G. Stone, A.M.
Henry D. Thompson, Ph.D.
Oskar Paul Wintersteiner, Ph.D.

Honorary Life Membership was conferred upon the following eminent scientists:

Brönstedt, Johannes Nicolas, R, Ph.D., Physical Chemistry. Thermodynamics and Solutions, Acid Base Concept. Director, Institute of Physical Chemistry, Bledgansvej, Copenhagen, Denmark. R = Knight of Flag of Denmark (Highest honor awarded in Denmark). Visiting Professor, Yale University, 1926; Special Guest, Chicago World's Fair, 1933.

Drummond, Sir Jack Cecil, Biochemistry, Nutrition and Vitamins, particularly A and E. Professor of Biochemistry, University College, London, England, 1919–1939; D.Sc., University of London; Fellow of the Royal Society, 1944; F. R. I. C.; Lane Lecturer at Stanford University, 1933; Harvey Lecturer, New York City, 1933; Falarian Lecturer, Royal Institute, 1944. Appointed

to Ministry of Food, Chief Scientific Advisor, 1939, concerned during war period with planning of British Food Program also with plans for Relief of Western Europe on liberation. Knighted in recognition of this service. Attached to SHAEF and 21st Army Group for study of nutritional problems as France, Belgium and Holland liberated; Advisor to British Control Commissioner for Germany and Austria, 1944–1945; British Delegate to Hot Springs Conference, 1943; British Advisor at Food and Agriculture Organization Conference at Quebec.

Kapitza, Peter, Physics. Low Temperatures. Director, Order of Red Banner of Labor Institute of Physical Problems; Member, Academy of Sciences of U. S. S. R., Moscow, U. S. S. R.; Honorary Member, University of Algiers; Member, American Philosophical Society; Honorary Member, Franklin Institute; Honorary Member, Institute of Metals; Member, British Institute of Physics; Member, British Royal Society; Member, Cambridge Philosophical Society; Member, Société de Physique de France; Honorary Member, Moscow Society of Naturalists; Fellow, Trinity College, Cambridge, England. Awarded Franklin Medal (U. S. A.); Faraday Medal (England); Twice, Laureate of the Stalin Prize.

Oliphant, Marcus Lawrence Elwin, Physics. Poynting Professor of Physics, University of Birmingham, England; Messel Research Fellow, Royal Society, 1931, Fellow and Lecturer, St. John's College, 1934; Assistant Director, Cavendish Laboratory, Cambridge, 1935; Fellow of the Royal Society, 1937.

Szent-Gyorgi, Albert, Medical and Organic Chemistry. Professor of Medical and Organic Chemistry; Director, University Institute for Medical Chemistry, University of Szeged, Hungary; M.D., Ph.D., University of Hungary; Visiting Professor, Harvard University, 1938; Awarded Nobel Prize for Medicine, 1937.

Swellengrebel, Nicholas Hendrick, Parasitology. Chief, Zoological Laboratory, Amsterdam Tropical Hygiene Institute, 1913; Professor of Parasitology, Amsterdam University, 1921; Member, League of Nations: Malaria Commission, 1924; Public Health Council, 1927. Darling Gold Medalist, League of Nations Organization for Hygiene and Public Health; President, Third International Congress on Malaria, Amsterdam, 1938.

Umbgrove, Johannes Herman Frederick, Geology. Professor of Geology, Technische Hoogeschool, Delft, Holland; Ph.D., University of Leyden, 1925; Geologist in East Indies, 1926–1929; Assistant Professor of Geology, University of Leyden, 1929.

Wenyon, Charles Morley, Protozoology. Director, Welcome Research Institution, 1944; Formerly, Protozoologist, London School of Tropical Medicine; President, Royal Society of Tropical Medicine, 1945. Awarded, Cross St. Michael and St. George, 1918; Companion British Empire, 1919; Fellow of the Royal Society.

The following officers were elected for the year 1946:

For President

WALTER H. BUCHER

For Vice-Presidents

CHARLES H. BEHRE, JR. ROSS F. NIGRELLI

EMILY T. BURR JOSEPH S. FRUTON

GEORGE HERZOG

For Recording Secretary
CHARLES M. BREDER, JR.

For Corresponding Secretary
H. HERBERT JOHNSON

For Treasurer
HARDEN F. TAYLOR

For Librarian
ERICH M. SCHLAIKJER

For Editor
ROY W. MINER

For Councilors (1946–1948)
HANS T. CLARKE
CHARLES GLEN KING
HANS MOLITOR

For Finance Committee
W. REID BLAIR, *Chairman*
MARVIN D. THORN
ADDISON WEBB

After the Business Meeting, the following papers were read on the subject of:

"FOOD, NUTRITION AND WORLD POPULATIONS"*

NUTRITION AS A WORLD PROBLEM
BY
DR. FRANK GEORGE BOUDREAU
Director, The Milbank Memorial Fund

NUTRITION AS AN EXACT SCIENCE
BY
DR. OTTO ARTHUR BESSEY
Public Health Research Institute of the City of New York

THE FUTURE OF NUTRITIONAL SCIENCE
BY
DR. CHARLES GLEN KING
Scientific Director, The Nutrition Foundation, Inc.

* The papers presented by Doctor Boudreau and Doctor King are published in this number of the Transactions.

NUTRITION AS A WORLD PROBLEM

By
FRANK G. BOUDREAU

Executive Director, Milbank Memorial Fund, New York, N. Y.

Food and nutrition have played major parts in determining the size and many of the characteristics of the world's population. They will continue to play major roles in the future. How the world's people are fed will affect the size of the population, its geographical and age distribution, its political complexion, its standard of living and even, to some degree, the issues of war and peace. Badly fed peoples do not necessarily decrease in numbers in this age of preventive medicine, but they do keep burning the fires of illiteracy, epidemics, social unrest and premature death. Food is so basic a need that even speculation about it may have serious consequences. Our farmers, farm leaders and agricultural economists anticipate the development of large surpluses in most of the major food commodities, as soon as the period of relief feeding is over. Action taken to prevent such anticipated surpluses (limiting production, for example) might well run counter to the requirements of a sound nutrition policy. For it is an ironic commentary on man's intelligence that the people have, as a rule, been least well fed when the largest food surpluses existed. The problem of feeding the unprecedentedly large world population that we expect in the future will not necessarily be solved by producing adequate amounts and kinds of food. We must also succeed in getting the food to the people. So far, however, we have been more successful in producing food than in properly distributing it.

The modern study of population problems may be said to have started with Thomas Robert Malthus, an English economist, who, in 1798, published his famous essay, "The Principle of Population as It Affects the Future Improvement of Society." Malthus assumed that man's sex passions were not likely to change and that food is necessary to man's existence. Population had always tended to increase rapidly and it would always increase rapidly, providing food or subsistence were available. According to Malthus, population would tend to increase to sixty-four times its original size, in 150 years (geometrical ratio), while its subsistence would increase only seven times (arith-

metical ratio). Accordingly, hunger, disease, vice and war were bound to be, in the future as in the past, the chief forces which would keep human population within reasonable bounds.

Benjamin Franklin had some influence on Malthus, for he is quoted in the first edition of the essay. Franklin's "Observations Concerning the Increase of Mankind and the Peopling of Countries," appeared in 1751. In this, he stated that the population of colonies would double every quarter of a century. In a curiously modern note, he also drew attention to the low fertility of the higher income groups: "The greater the common fashionable expense of any rank of people, the more cautious are they of marriage." Accordingly, Franklin advocated increase, Malthus, decrease in population. Franklin saw the great need for more people to develop the sparsely settled colonies, while Malthus was influenced by the squalor and misery of masses of people whose numbers had increased so greatly with the advent of the industrial revolution.

Let me survey briefly what we have learned about population growth, as a result of the stimulus furnished by Malthus and others of his kind.

Kingsley Davis[1] likens the growth of world population to a long thin powder fuse that burns slowly and hesitatingly, until it reaches the charge and explodes. For thousands of years, while man depended on hunting and fishing for his sustenance, the world's population remained exceedingly sparse. The first real burst of population growth came with the industrial revolution, which not only gave an unprecedented impetus to population growth in Europe, but extended its influence throughout the world.

"For the first time the world's entire population could be regarded as a single entity responding in various degrees to one dynamic process. For the first time the movement of human masses across oceans became feasible. For the first time a new type of balance between births and deaths—a balance less wasteful than the old—began to manifest itself."[2]

Even today, we do not know the exact size of the world's population, but students have been able to make reasonable estimates of numbers and rates of increase since the middle of the seventeenth century. Thus, in 1650, the world's population is estimated to have been

[1] **Davis Kingsley.** The world demographic transition. Ann. Am. Acad. Pol. Soc. Sci. 1945.

[2] *Ibid.*

545 millions. It grew to 728 million, in 1750; to 906 million, in 1800; to 1,171 millions, in 1850; to 1,608 million, in 1900, and to 2,171 million, in 1940. Rates of increase also continued to accelerate. The rate of growth for 1650–1750, 0.29 per cent annually, was the lowest for any like period in recorded history, and, in the following period (1750–1800), it nearly doubled. The rates for subsequent periods were, 0.44 (1750–1800); 0.51 (1800–1850); 0.63 (1850–1900); and 0.75 (1900–1940). These rates may not appear high, but, if the present rate were to continue, the population of the world in the year 2240, less than 300 years from now, would be 21 billion inhabitants.[3]

Just what caused these great increases in the world's population? Population growth is determined by fertility and mortality, through which all other factors must act. There is no reason to believe that there has been any significant increase in fertility in any considerable area of the world since 1650; there is evidence to show that fertility has actually declined. Hence, the cause of the growth of population must have been the decline of mortality. According to Kingsley Davis, "the reduction in mortality began primarily with a more abundant, regular and varied food supply. The indications are that the average expectation of life at birth has practically doubled since the late seventeenth century."

In the latter part of the nineteenth century, fertility, which had at first remained high, began to decline in the northwest of Europe.[4] This trend soon moved east and south, across the continent, meanwhile becoming well established in North America, Australia and New Zealand. "These are the only populations that have controlled their fertility sufficiently to bring birth rates into balance with the low death rates that modern conditions permit. They are the only populations that have thus far shown a way by which growth can be checked other than through death; the only ones that have attained high efficiency in the maintenance of the stream of life."

By 1940 or earlier, fertility in these countries had fallen below the level required for the permanent maintenance of a stationary population at existing levels of mortality. Their population growth continues only because of the present favorable age distribution, which time will soon alter.

[3] *Ibid.*

[4] **Notestein, Frank W.** Population—the long view, in Food For The World. Harris Foundation Lectures. University of Chicago Press. Chicago. 1944.

These countries are, therefore, classified by Notestein as those of *incipient population decline.* They are expected to reach their maximum between 1950 and 1970.

Populations in certain other regions are in an earlier stage of demographic evolution, but the decline in their birth rates is already well established. The populations of Eastern Europe, the Soviet Union and Japan, certain Latin American countries, Turkey, Palestine and parts of North Africa belong in this category, which is known as the stage of *transitional growth.* Japan is the most interesting example of this class, "for it is the only Eastern country that has gone through a substantial period of modernization and urbanization, hence the only one in which the demographic responses to these changes can be compared with those of the West."[5] Notestein points to the marked similarity between the trend of birth and death rates for Japan from 1921 to 1941, with those for England and Wales from 1881 to 1901. Populations in the stage of transitional growth increase enormously after fertility begins to fall, for it always lags behind the decline in mortality. Between 1821 and 1921, the population of England and Wales increased threefold, in spite of substantial emigration. If the population of Japan should follow the same course as in England after 1821, its population would probably approximate 95 million inhabitants, by 1970.

More than half of the world's population has not yet entered the period of transitional growth. Populations having *high growth potentials,* the third great division, are found in Egypt, central Africa, the Near East, Asia outside of Japan and the Soviet Union, the Islands of the Pacific and Caribbean, and much of Central and South America. The case of India throws light on the significance of high growth potential. From 1872 to 1921, periods of slow growth alternated with periods of rapid increase. There followed, for the first time in recorded history, two successive decades of rapid growth, and in those twenty years India's population increased by 83 million. It is now over four hundred million, about equal to the population of all Europe, west of the Soviet Union. These countries of high growth potential, typified by India, constitute one of civilization's most difficult problems.[6] If nothing is done for them or by them, they will, so far as we

[5] *Ibid.*

[6] Many countries in this stage present no immediate problems, since they are sparsely settled and of slow population growth. The difficulty will come when the present very high mortality is brought under some control.

know, remain in the stage of high growth potential, periods of extremely rapid growth alternating with periods of slow growth or of decline, when famine and disease sweep through the population. In our modern world, however, we cannot do nothing, for our own safety demands action. We cannot allow disease to flourish unchecked in these lands, since the world is now so small that epidemics in any part of the globe threaten our own existence. We have learned that the only successful way to prevent epidemics is to deal with their sources, before the sparks have burst into flame. This means sanitation, a sound system of health administration, health education of the people, medical care and improved nutrition. Hence, if we attempt, as we must, to abate the sweep of epidemics, mortality will decline in populations of high growth potential and numbers will greatly increase. To do nothing and be forever faced with the problems of high growth potential, epidemics, misery and, probably, revolution; to do a little to check epidemics and be confronted by enormous increases of miserable peoples whose numbers more than keep pace with their increased food production; these are two of the choices with which modern society is confronted. Fortunately, there is a third choice: to assist these countries to advance socially, politically and economically, so that they may pass rapidly through the stages of population growth and attain, as some Western countries have done, a more reasonable balance between births and deaths. This, as I see it, is our only hope. "For it is only when rising levels of living, improved health, increasing education and rising hope for the future bring new value and dignity to the individual's life that old customs break and fertility comes under control. Without such control the world's population is limited only by its carrying capacity. In the long run it remains true that the control of mortality without the control of fertility is impossible."[7]

On the assumption of general order and the spread of modern techniques, Notestein believes that a world total of three and a third billion inhabitants, in the year 2000, is a conservative estimate. If, in the East, there should be a rapid increase in production within a slowly changing social framework, by the year 2000 an Asiatic population of well over two billions—about equal to the world's present population—would probably result. And a world population of three

[7] *Ibid.*

billions, within two generations, is not by any means a remote possibility.

This is a world problem, it cannot be dealt with unilaterally. Countries with populations in the stage of incipient decline are setting up commissions to study their problem. If experience is any guide, these committees will recommend measures designed to increase the number of their inhabitants. In the meantime, half of the world's population is in the stage of high growth potential, with all that this stage implies: periodic famine, such as we have witnessed recently in Bengal and China, high illiteracy, malnutrition and disease. All four are a menace to society throughout the world. In that half of the world's population which is in the stage of high growth potential, the expectation of life is about the same as that which probably prevailed in the advanced countries, prior to the industrial revolution. There is a shocking contrast between, for example, New Zealand and The Netherlands, where expectation of life at one year is over 65 years, and Egypt and India, with rates of 36 and 26 years, respectively. In 1938, some 12 per cent of the world's people lived in countries where the average expectation of life was 64 years or over, while 70 per cent lived in countries where the average span of life was under 50 and, frequently, well under 40 years.[8]

Turning now to another aspect of our subject, we may ask, Is it possible to produce enough of the right kinds of food adequately to feed the world's present and future population? Looking ahead only a few years, the problem is an entirely different one. It is whether we can maintain *food consumption* at a high enough level to prevent food producers from being impoverished by the very abundance of their production. Hunger and starvation are the lot of millions in the world today, yet the economist, looking into the future, sees food surpluses developing like those which ruined many of our farmers and our markets, in the 1930's. Wheat[9] is almost certain to be in a surplus situation, as soon as the relief feeding period is over, and this situation is likely to be chronic. Existing markets will find difficulty in absorbing the supply of fats and oils, when Pacific supplies become available

[8] Memorandum by **F. L. McDougall.** The Quantity and Physical Quality of Life in Relation to Poverty and Malnutrition. Prepared for the United Nations Interim Commission on Food and Agriculture. Washington. 1944.

[9] The following predictions are taken from an article by **Walter W. Wilcox.** Food supplies in prospect after the war, in Food For The World. Harris Foundation Lectures. University of Chicago Press. Chicago. 1944.

again. There will be a surplus in sugar, as soon as the present demand for industrial alcohol declines. With the expected increased supplies of animal protein, the demand for *pulses* is expected to decrease, and these will be in surplus unless production is adjusted. Rice is likely to be in a postwar situation similar to wheat. Fruit surpluses are likely to develop, in this country, and animal protein supplies will be in surplus, unless there is full employment. When military requirements cease, market surpluses will develop in vegetables. More food will be produced after this war than ever before in history, and market surpluses in a number of food commodities will appear at an early date.

In the face of these beliefs, which are shared by most food economists, we need not give much thought to the danger of future food shortages. For the Western world, at least, the gloomy predictions of Malthus have not been fulfilled.[10] World population has increased, but world food output has increased faster. The opening up of new lands and the application of scientific discoveries to farming have brought about a prodigious increase in agricultural output. For over two hundred years, man has produced more and more food with each succeeding decade. Mechanization and increased and better use of fertilizers and other technological advances have been put to work over a comparatively small fraction of the world. They are bound to be extended, in the future. The present increase in production is due to these and many other developments. The boundary of cropping has been pushed farther north in Canada and the Soviet Union, by the introduction of new cereal varieties and new vegetables. In India and elsewhere, hundreds of thousands of new acres have been opened up by irrigation. There has been a general increase in yields per acre, due to such advances as hybrid corn, disease-resistant varieties of cereal, new grasses and improved vegetables. New developments in the production and use of fungicides have reduced losses, especially in fruit and vegetable growing. There have been great increases in the numbers and productivity of livestock, through better breeding, increased understanding of animal nutrition and more effective prevention of animal diseases. And there have been great advances in farm and marketing equipment of all kinds, such as farm machinery, storage facilities, refrigeration, and transport.

[10] Report of the Technical Committee on Agricultural Production, in Five Technical Reports on Food and Agriculture, submitted to the United Nations Interim Commission on Food and Agriculture. Washington. 1945.

There are still other opportunities to increase the world's food supplies. We know far too little about our resources in fish. Some 98 per cent of the world's catch is drawn from the Northern Pacific and Northern Atlantic Oceans.[11] Opportunities exist for expanding the fishing industry, in South America, Asia and Africa; the resultant production would improve diets and yield additional dividends in the form of vitamin oils. The food supply may also be augmented by cultivating fish in fresh water ponds. This would contribute needed protein to the diet of people in many parts of the world.

War experience has clearly revealed that better use can be made of the food produced in almost any country. During the war, we produced, in this country, enough food to feed a population one and a third times as great as our own. A Committee of the Food and Nutrition Board showed that, with slight changes in production and consumption, we could have fed a population twice as large as our own and actually improved the diets of our own people. All that was needed was more emphasis on the production of nutritionally desirable foods that are economical in land, manpower and transport, and the shifting of increased proportions of skim milk, wheat and barley, soy bean and peanut products, from the feeding of livestock into direct human use as food. Hence, by intelligent food management, the available world supplies of food can be made to go further and to promote better nutrition.

In the face of world food supplies, which appear to be more than adequate, what is the state of the people's nutrition throughout the world? We lack the data upon which to base any precise answer to this question, but we do possess sufficient information to draw some reasonably sound conclusions. Such conclusions were reached by a Committee of Agricultural, Economic, Nutrition and Health Experts, set up by the League of Nations, in 1935, to study both the health and economic aspects of the nutrition problem. Their report, issued in 1937, has probably done more to stimulate public interest in food and nutrition and to point the way for national and international action than any other contribution to the subject.

In the United States and Canada, said the Committee, much malnutrition existed among the lower income groups. Available data sug-

[11] Report of the Technical Committee on Fisheries, submitted to the United Nations Interim Commission on Food and Agriculture. Washington. 1945.

gested a figure of between 20 per cent and 30 per cent of the entire population. Information on nutrition in Great Britain was available in a remarkable report by Sir John Boyd Orr, *Food, Health and Income*, which appeared in 1936. Applying the results of an extensive survey to the entire population, the report concluded that, in England, the average diet of the poorest group, comprising 4½ million people, is, by the standard adopted, deficient in every constituent examined. The second group, comprising 9 million people, is adequate in protein, but deficient in all the vitamins and minerals considered. The third group, comprising another 9 million, is deficient in vitamins and minerals. Complete adequacy is almost reached in group four (9 millions), while, in groups five and six (the wealthiest groups comprising 13.5 million people), the diet has a surplus of all constituents considered. The Committee pointed out that, in the British Dominions, although food consumption was relatively high, malnutrition was not uncommon, especially among children. In Central and Eastern Europe, malnutrition prevailed extensively and there was often a lack of staple foods as well.

The Committee agreed that the diets of the great mass of the population in the East were grossly deficient in terms of any standards of adequacy put forward by nutrition workers, and that nutrition was of far greater importance to the people of the East and to Eastern health workers than is the case in the West. In Asia and the tropics, about 75 per cent of the 1,150 million inhabitants consumed diets far below the standard for health.

This outline of the nutritional status of the world's people has been greatly supplemented, since 1937, for the League's work stirred the Governments to new activity. All of the new evidence, from whatever source, has served to emphasize and accentuate the picture drawn by the Committee. Famine in China, The Netherlands East Indies and India, and the serious aggravation of malnutrition in Europe, due to the war, make it plain that we have a long way to go before we can be satisfied that the larger part of the world's population enjoys a diet which contains even a bare minimum of the nutrients essential to health.

I have already suggested that the worst diseases have their chief source and habitat among populations having the highest fertility rates. It is not surprising to find that, as a rule, the worst and most extensive

malnutrition is also found in population groups with the highest birth rates. These people inhabit the less advanced countries; their expectation of life is low, because of the mortality which takes a high toll in every age group, but particularly at the younger ages. In India, nearly half of the total mortality occurs in children under ten years of age, a percentage about five times greater than that of Western countries.

Perhaps I have not made it plain that there is no geographical division of the world into two parts; one part enjoying relatively low death rates, low fertility and, at least, moderately good nutrition; and the other having high death rates, high fertility and great malnutrition. The world's *population* may be divided roughly into these two parts, but even the richest countries, among their poorer classes, have large groups with relatively high fertility, death and malnutrition rates. Taking the standardized death rate for the United States, as whole, at 100, the figure in 1940 for North Dakota was 60.2, for Iowa 79.6, for Massachusetts 96.3, for Mississippi 114 and for South Carolina 125.

The picture I have drawn for you is a dark one, but there are many gleams of sunshine on the horizon. The war has taught us that the right kinds of food can be produced and transported to supply the needs of the nation or a group of nations, even when war interposes seemingly insuperable obstacles. During the war, far more food was produced than we would have thought possible in prewar years. Our food supplies were managed in such a way as to conserve land, manpower, transport and critical materials. They were distributed more efficiently than ever before in history, with emphasis, especially in the United Kingdom, on the physiological needs of the people. Among the Allies, the food situation was most acute in the United Kingdom, and it was there that the greatest efforts were made to feed the people adequately. What the results have been is told by Sir Wilson Jameson, Chief Medical Officer of the Ministry of Health, in a broadcast message to his people in October, 1944:

> After five years of war we still have a good story to tell. The most sensitive index of a nation's general health is probably the proportion of infants dying in the first year of life. In the last war it rose steadily. During the last three years it has declined steadily and, last year, was the lowest ever recorded. The most risky time for a baby is its first month of life. Well, we've got a new low record there; and as for the tragedy of babies born dead (stillborn as we say) I can tell you that the chance of this happening is only three-fourths of what it was five years ago. The death rates for children up to ten years of age were last year the

lowest on record, as was also the proportion of mothers dying as a result of their confinements. As the war has gone on, the vital statistics for mothers and children have continued to improve and in the fifth year they're the best we ever had. This can't be just an accident. All that's been done to safeguard mothers and children must have had some effect—such things as the national milk scheme, vitamin supplements for mothers and children, the great extension of schemes for school meals and milk in schools. There are doubtless other factors—full employment and higher purchasing power in many families, especially in the old depressed areas; as well as the careful planning from a nutritional point of view of the restricted amount of food available for the nation.

Advances in science have provided us with materials with which to build a new world. An essential condition of success is that the peoples of the world must work together in building it. Otherwise, it will be a house of cards. After the first world war, the different countries attempted to retire behind their national frontiers, building up social, political and economic walls to keep out foreign ideas, foreign goods and foreign influences. The worldwide economic depression, followed by the war, revealed the folly of attempting to break up the world into tight compartments. There was no chance of winning the war, until full cooperation developed among the Allies. It is pertinent to our subject to recall that food, as a weapon of war, was planned, produced, processed, transported, allocated and distributed according to plans worked out by joint committees of experts from the allied governments.

We are attempting to continue joint food planning, by means of two United Nations agencies: UNRRA and FAO. UNRRA is for the short term. I am convinced that UNRRA will go down in history as a magnificent conception of farsighted men who understood that, in the modern world, it is the part of enlightened self interest to restore neighboring nations to decent conditions of living and work. FAO, which was established a few weeks ago at Quebec, is for the long term. By setting it up, the Governments have agreed not to go back to the methods and ways of the interwar period, but to continue, in peacetime, the cooperation in food and nutrition which helped to bring victory in the war.

The first conference at Quebec selected Sir John Boyd Orr of Aberdeen as their Director General, and he thus became the first full time official of the United Nations. Sir John, as many of you know, won his spurs in animal nutrition. He proceeded to build up a reputation in human nutrition, and he is known, throughout the world, for his interest and concern for the hungry and malnourished among the world's people. The selection of Sir John Orr was proof that the Governments

were sincere in their resolve to work together to raise the standards of living of their people and to banish hunger and want from the world. The conference at Quebec was a sober gathering of technical experts and responsible statesmen, fully aware of the difficulties and complexities of their task, appreciating that the many-sided problems of poverty and malnutrition required many different forms of attack, by many United Nations agencies, in trade, finance, industrial development, education, transport and politics, and resolved to do their part so well that they would set an example to all the others.

Looking back on the history of our own country, I do not find that our difficulties and troubles were ever solved, more than temporarily, merely by the strengthening of police powers. On the contrary, progress has been due to our success in developing our natural and human resources, by such things as wages and hours and other social legislation; by the development of our system of education; and by the building up of institutions and policies which permitted the human spirit to grow and flower. The world today—physically, socially, economically, and politically—is smaller than the world Washington and Jefferson knew, when they labored to lay the foundations of this republic. If the advance in science is to prove a blessing and not a curse to mankind, we must think in world terms and build up for our world the social, economic and political institutions which will set mankind on the road to freedom from the misery, want, disease and premature death which have been man's companions for so many centuries. As the member from New Zealand said at Quebec, when the Food and Agriculture Organization was established:[12]

> At this vital time the opportunity is given to few organizations to contribute more directly to human welfare, and, in so doing, to make more permanently secure the foundation upon which world peace must ultimately rest; for neither political alliances nor military commitments, nor atomic bombs, nor regional arrangements can guarantee security for long in a world that is afflicted with poverty, pestilence and famine.

[12] Journal of the First Session of the Conference of the Food and Agriculture Organization of the United Nations 1 (4): 40. Quebec City, Canada. 1945.

NUTRITION AS AN EXACT SCIENCE

By

OTTO A. BESSEY

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(Illustrated)

Dr. Bessey and his associates have developed remarkable techniques of direct quantitative measurement of the nutritional state of individuals by micro-chemical analysis of a few drops of blood. These results he presented, together with the clinical signs of malnutrition and their statistical application to school-children and other groups, as examples of exact science in the advancement of nutrition.

THE FUTURE OF NUTRITIONAL SCIENCE

By

CHARLES G. KING

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The two previous speakers have made it clear that the future of nutritional science is not only going to be woven into the complex fabric of other sciences, but it is destined also to play an important role in social and economic progress.

The primary objectives that nutritional scientists see ahead are not difficult to state, but they are undoubtedly going to be difficult to achieve: We want to find what quantity of each of the forty or more essential nutrients is required for good nutrition, how each nutrient functions inside the body, how each can be used to protect human and animal health, and how each can be measured accurately, either as it functions in the body or as it comes into being on a farm and later takes its course through the channels of commerce.

This goal may not sound formidable, but I think it is safe to suggest that if everyone in the audience had a Ph.D. or M.D. degree and could have as many research assistants as desired, plus an opportunity to work for a hundred years without interruption, there would still remain large segments of the goal to be achieved. In other words, Dr. Vannevar Bush rendered a valuable public service when he entitled his recent book "Research, The Endless Frontier."

Few people realize how limited our present knowledge is, in regard to human nutrition. For example, we still do not know what chemical elements and compounds must be supplied to the human body to meet its basic requirements for growth and health.

Most authorities would agree that at least 19 elements are needed by some forms of life, but the evidence scarcely goes beyond 10, in relation to human feeding.

Of the 23 common amino acids that constitute our protein foods, it appears that only 8 are required by the adult human. However, we know almost nothing of special requirements for other conditions, except that of maintaining a nitrogen balance in a normal healthy adult. Animal tests give only a very rough indication, because each animal tested, thus far, shows distinct variations from the others.

Of the 15 or more vitamins that have been discovered by animal experiments, the tests in human feeding cover only 9, clearly, and three others, in part. It is worth noting, however, that, up to the present time, the human has not been found capable of synthesizing a vitamin required by any test animal.

With regard to fats, although a few animals appear to need one of the 43 or more fatty acids, practically nothing is known of the human need for fats, other than for three of the fat-soluble vitamins.

Neither is there any clear picture of the human need for carbohydrates, although they normally supply about one-half or more of all human and animal energy.

At first thought, one might be critical of the current expenditure of funds to find how the individual nutrients function in living cells, but we are confident that this field lies at the very heart of understanding other aspects of the science. If scientists can find out what the nutrients do inside living cells, including the human body, then agriculturists, food technologists, physicians, dietitians and public health workers will be in a position to produce, distribute and use foodstuffs on a far more rational basis. Without such information, men are forced to make important decisions on the basis of rule-of-thumb or guesswork, and that is not good. It is, certainly, the extreme opposite of what this Academy stands for in community life.

There is always a temptation to indulge in a bit of crystal-gazing, when one is looking into the future, but I think we get our best clues when we join with our fellow scientists in thinking out loud. We start, then, from the current zone of experimental evidence and visualize our next moves within that discipline.

The normal, adult, human requirement for each of the amino acids supplied in such protein-rich foods as milk, eggs and meat will soon be known. There will still remain such questions as:

(a) What are the special requirements during growth?

(b) What are the special requirements during pregnancy and lactation?

(c) What are the special requirements during convalescence from injury and infection?

(d) What are the special requirements to build up maximal resistance against infection?

(e) What are the special requirements to permit optimal adjust-

ment to extremes of environment such as cold, heat, high altitude and restricted water intake?

(f) What are the upper limits to a satisfactory protein intake? Nutritionists want to know the approximate optimal range for each nutrient, as well as the critical levels.

(g) And to what degree do each of the above six items vary with differing types of proteins?

As these functional needs become known, in terms of the consumer, the medical profession and the respective areas of agriculture, education and the food industry will be in a position to adequately advise and supply the public. The essential or desired amino acids, for example, can then be obtained, at the discretion and pleasure of the consumer, as caviar, or filet mignon, or just plain bread and milk. I see no serious threat that the public will prefer two pounds of pills and a bottle of distilled water to ordinary food. The synthetic amino acids and protein hydrolysates will, of course, come into their proper areas of use, in time. So far as the distilled water is concerned, I have not been able to observe, especially since coming to New York, that the consumption of distilled material is based on water content at all.

Despite the very great importance of fats in animal physiology and in industry, very little is known regarding even such simple things as their comparative nutritive quality, or the chemical changes by which they are formed, or the chemical steps by which they are used in living cells. Until very recently, one might say with complete fairness, the literature on fats afforded a critical scientist very "lean pickings." It is interesting, also, to note that a considerable portion of the more promising recent work on fats, such as that of Dr. Stettin and his associates at Columbia University, stems chiefly from the study of carbohydrates.

The chemistry and physiology of sugar utilization has been moving ahead rapidly in recent years. The group associated with Dr. Clarke and the late Professor Schoenheimer at Columbia University has been very productive, as many of you know. At Washington University, Dr. Carl Cori has recently published a short paper that augurs many important findings. Having previously isolated several of the enzymes that control by catalysis the use of blood sugar, Dr. Cori's group then showed, for the first time in history, how two of the hormones function in terms of their molecular reactions.

This remarkable work of Dr. Cori's group, taken in conjunction with progress in other laboratories where the chemical aspects of diabetes are under investigation, gives one great encouragement. Medical authorities believe that one person in every one-to-two hundred has a metabolic disturbance of diabetic type. It seems very reasonable to hope that, with further research, the cause or causes of diabetes will soon be identified. Then, having identified and understood the cause, those who work toward better public health should be able to develop techniques and educational measures to meet the challenge of preventing the onset of the disease. Insulin has been a great boon to humanity; but to prevent diabetes would be a far greater one.

Of the many reports relating food intake to health, few have received so much attention as the recent papers from Harvard University. Dr. Harold Stuart, Mrs. Burke and their associates reported summary findings, after 12 years of careful study. The diets of mothers living in wage earners' homes in the Boston area were classified as to nutritive quality and these records were later correlated with the health records of the mothers and their infants. If the correlation between food intake and health over the rest of our country should be shown to be even remotely like that reported by the Harvard group, the appeal to do something about it would be irresistible. It would mean an improved initial health rating for approximately 900,000 infants per year in the United States. To provide more information in this field and to serve as a stimulus to education in nutrition, several projects like the Harvard study should be under way in different areas of this country and in others. Furthermore, such studies should be extended, in time, to cover the whole life span, as Dr. Sherman has done in his experiments with albino rats. The cumulative effects of consistently good or bad diets have given such striking records with albino rats, under controlled conditions, that there is no sound basis for doubting their analogy, in a broad sense, to human feeding. Nevertheless, we critically need the scientific evidence, obtained and interpreted by persons with the highest professional standing, and as applied specifically to the *genus homo*. With apologies to our latin scholars, one might say, regarding the human situation, that, instead of having good data from which to draw conclusions *"ex-post facto,"* we are still forced to reason too largely *"ex-post albino."*

A promising project in the public health field has been initiated at

the Mayo Clinic, in cooperation with the local health department, but it has very different features than the work outlined by Dr. Stuart's group in Boston. One aspect of the Rochester plan is especially commendable, in that it anticipates a long period of observation.

Additional plans for maternal and infant nutrition research offer special promise. These projects illustrate the constant need to keep human nutrition research following as closely as possible along the lines indicated by findings with experimental animals. For example, Dr. Warkany's work with albino rats shows beyond dispute that deficiencies of vitamins A and B_2, during early pregnancy lead to frequent physical deformities in the offspring. The deformities often affect the eyes, the feet, the vertebrae, the jaws (so that they are too small for good tooth development); and occasionally Dr. Warkany finds conditions resembling "clubbed feet" and "cleft palate." A closer check of such possible relationships can be secured by studying monkeys or other primates, because their anatomical changes and nutritional requirements are so nearly human. Physicians will then be in a better position to look backward into the history of an individual patient who is the victim of a deformity, and, very possibly, identify the cause. Then, by education alone, there would be an opportunity to ward off many bitter human experiences. Dr. Warkany has estimated that human physical deformities at birth result in more deaths per year in the United States than are caused by diphtheria, whooping cough, scarlet fever and measles combined.

The subject of dental caries, or tooth decay, reaches into the personal experience of nearly everyone. Furthermore, there is reasonably good evidence that the incidence of dental caries has been rising, during the past two decades. It is now stated to be the most prevalent disease in America. Until they lowered the standards for Selective Service acceptance in World War II, it was the most frequent single cause for rejection on physical grounds—actually reaching over 20%, among the first two million called. Since it reaches so far down in the younger age groups, perhaps it should not be classed as a degenerative disease, but it does represent, in most cases, a premature decay of a mature tissue. There is no need to quibble over the question of whether oral environment, such as the presence of bacteria, sugars, and acids, may affect the degree of tooth decay, but I think there is a high probability that, in time, it will be found that good or bad food

practices are responsible in major degree for the health and stability of a mature tooth.

Other diseases that we may expect to give way, chiefly in the sense of postponement or decreased rate, when good nutrition is maintained, are certain types of heart failure, high blood pressure, aging of the skin, intestinal disorders, anemias, some types of liver and kidney diseases and of visual impairment. You will note that most of these diseases are chronic in type, and that, in so far as they are related to nutrition, one must study them in a perspective of many years.

There is little doubt, in the minds of those who are close to the current research frontier, that nutrition is destined to play an increasing role in regard to public health, preventive medicine, agriculture, food processing and distribution, lay education and the food habits of the general public.

In the pure research field, then, one can look forward to seeing an endless frontier of exploration into the mysteries of what happens inside a living cell. From the single cell, a gradual extension can be made to the human body. It is quite as clear, also, that research and guiding principles in the science of nutrition will include increasing emphasis upon the concept of a full life span and secondary effects upon succeeding generations.

JOHN ARCHIBALD WHEELER, Princeton University: *Polyelectrons.* (A. Cressy Morrison Prize Winner, 1945.) (Abstract.)

This paper is an extension of our knowledge about the interaction of positive and negative electrons. Already available experimental and theoretical evidence has shown that pairs of these particles may be produced from a vacuum by the action of electromagnetic radiation, and, conversely, that a pair consisting of an electron and a positron may undergo annihilation with the release of two quanta of electromagnetic energy.

The present paper shows that, preliminary to such an annihilation process, the electron and positron may circulate about each other in orbits closely resembling those of the hydrogen atom. The entity so constructed is given the name of bi-electron and is calculated to have a lifetime of 10^{-6} second or 10^{-10} second, according as the spins of the positive and negative electrons about their own axis are directed in the same direction or in opposite directions. It is shown that similar systems may exist with more than two electrons. Also, figures are given for the probability of creation of such polyelectron systems from a vacuum by the action of electromagnetic radiation.

The properties of these polyelectrons are compared with those of the cosmic ray mesons. The two types of system resemble each other in having lifetimes against radio active disintegration or annihilation of the order of magnitude of a microsecond and in having masses which are multiples of the electronic mass, but are distinctly different with respect to calculated penetrating power and geometric extension or size. An experiment is outlined by which it should be possible to check the theoretical prediction that the two quanta of electromagnetic radiation, given off in the process of annihilation of an electron and a positron, are vibrating in planes perpendicular to each other.

It is concluded that the study of polyelectrons is a logical step in the further development of the theory of electrons and positrons, and in the application of this theory to the study of cosmic ray problems.

MAX J. HERZBERGER, E. Kodak Research Laboratories, Eastman Kodak:
The Limitations of Optical Image Formation. (A. Cressy Morrison Prize Winner, 1945.) (Abstract.)

The aim of this paper is to familiarize the optical designer with a new and powerful tool for the investigation of the image-forming qualities of an optical system.

The rank of the matrix, containing the second-order derivatives of a function, called the diacharacteristic, discloses the quality of the image obtained, whether sharp, unsharp symmetric, or unsymmetric. Thus, the lense-designer can compute the characteristic function of ray-tracing; by examining diagrams, he can determine whether the points in which he is interested have any of these qualities.

This method, which is of even greater value in the theoretical field, is here utilized in investigating the limitations of optical image formation. Answers are supplied, in particular, to such questions as: Do there exist systems which image the whole space sharply, or at least symmetrically? How many surfaces can any one image sharply?

Many classical examples demonstrate that the diacharacteristic permits straightforward solution of optical problems by the manner in which a system images any point. However, the way to a fundamentally different treatment—as, for example, in the analytical expression of errors of distortion—is pointed out by this technique.

The geometry of diapoints is discussed, as well as their coordinates expressed as various functions. The laws of image formation are examined, both for a finite and for an infinite object point. Finally, the characteristic functions for several interesting, special kinds of image formation are found, and the usefulness of the characteristic function to the investigator is plainly demonstrated.

LEONARD G. WORLEY, Department of Biology, Brooklyn College: *The Golgi Apparatus—an Interpretation of its Structure and Significance.* (Honorable Mention, A. Cressy Morrison Prize Competition, 1945.) (Abstract.)

The configuration in fixed animal tissue, to which the term "Golgi apparatus" has been applied by cytologists, is the manifestation of a series of more or less spherical Golgi bodies of the living cell. These bodies are believed to be the visible expression of the more or less temporary aggregation of ultramicroscopic colloidal particles, probably including phospholipids, ribo-nucleic acid or ribo-nucleoprotein and, frequently, ascorbic acid.

To this basic chemical structure are added, when available, through absorption from the cytoplasm, various raw protein and fatty materials. Since the proportion and character of these raw materials shows considerable variation in different cells and probably even within the same cell at different times, the Golgi elements show a correspondingly great variability in their total chemical composition. This is reflected in differences in structure, staining reaction, degree of osmiophily, viscosity, specific gravity, solubility and the nature of the Golgi body product in various situations.

The basic Golgi substance converts these raw materials into various products of a protein and fatty nature. It is believed to be directly responsible for the formation of all secretory granules, whether these are to remain within the cell or are destined to be discharged, as in the case of glands. Aggregation of the colloidal particles precedes product formation and the release of the product is usually accomplished through the partial or sometimes complete dispersal of these particles.

New Golgi elements may arise from pre-existing Golgi bodies, but new particles are believed to be cast into the cytoplasm, from time to time, by the nucleolus, especially during oögenesis. The phospholipid fraction may become incorporated after the particles of nucleic acid reach the cytoplasm. Mitochondria are believed to have a somewhat similar origin, but are thought to be relatively more stable, once formed, and probably also more constant in chemical composition.

Studies of the Golgi apparatus should always involve a comparison between fixed and living tissue. No structure in the cytoplasm of

either the vitally stained or the fixed cell should be accepted unless there is fairly perfect correspondence between the two types of material. In general, structures that blacken with prolonged osmication and stain vitally with methylene blue may be considered a part of the total Golgi complement of the cell. But, in the final analysis, judgment should be based, wherever possible, on a study of these inclusions through the entire cycle of activity.